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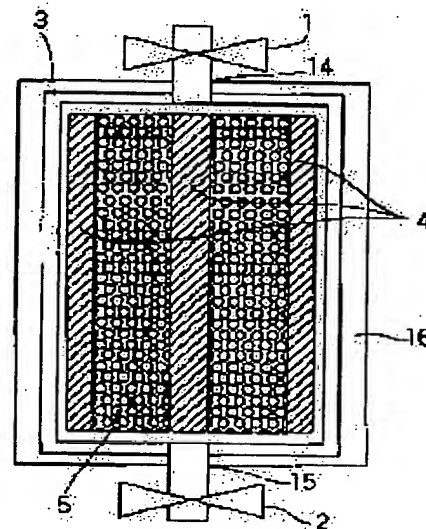
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(54) DEVICE FOR REMOVING ORGANIC MATTER IN WATER AND SYSTEM FOR REMOVING ORGANIC MATTER IN WATER

(57)Abstract:

PROBLEM TO BE SOLVED: To exhibit the removing performance of the org. matter in water over a long period of time without substantially throwing away activated carbon and substantially eliminating the exchange of the activated carbon.

SOLUTION: The photocatalyst-carrying activated carbon layer 5 carrying a photocatalytic material on the surface and adsorbing the org. matter in the water, the light source 4 capable of emitting light to the photocatalytic material, the activated carbon layer 5, the housing part 16 for housing the activated carbon layer 5 and the light source 4 and also having the water inlet 14 for allowing water to be treated to flow in and the discharge port 15 for discharging the liq. passed through the activated carbon layer 5 and the reflective coating 3 provided at the inner wall of the housing part 16 and reflecting the light emitted from the light source 4 are provided. The material capable of decomposing the org. matter in the water adsorbed on the activated carbon layer 5 is used as the photocatalytic material. Then the decomposed matter of the org. matter in the water is removed by using the water, etc., to be treated.



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CLAIMS

[Claim(s)]

[Claim 1] Touch some of activated carbon which adsorbs the underwater organic substance, and said activated carbon [at least], and a predetermined light is used. While containing the photocatalyst matter which disassembles the underwater organic substance which stuck to said activated carbon, the light source which can emit said light to said photocatalyst matter, and said activated carbon, said photocatalyst matter and said light source The underwater organic substance stripper characterized by having the stowage which has suicide-by-drowning opening which flows processed water, and the exhaust port which discharges the liquid which passed said activated carbon.

[Claim 2] The underwater organic substance stripper according to claim 1 characterized by having further a reflective means to reflect in said said activated carbon and photocatalyst matter side the light which it was prepared in the wall of said stowage and said light source emitted.

[Claim 3] Said activated carbon is an underwater organic substance stripper according to claim 1 or 2 characterized by supporting said photocatalyst matter on the front face.

[Claim 4] Said light source is an underwater organic substance stripper given in either of claims 1-3 characterized by the ability to emit said light intermittently.

[Claim 5] Underwater organic substance stripper plurality given in either of claims 1-4, and the suicide-by-drowning selection means for making said processed water flow into all or the part of said two or more underwater organic substance strippers, A treated water discharge means to discharge the treated water processed by said activated carbon from all or the part of said two or more underwater organic substance strippers, The underwater organic substance removal system characterized by having an organic substance content water discharge means to discharge a liquid including the decomposition product of the underwater organic substance which was sticking to said activated carbon disassembled with said photocatalyst matter from the part of said two or more underwater organic substance strippers.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention begins water and sewage, and removes the organic substance in gray water, treatment-of-human-waste water, waste industrial waters, the river where a degree of contamination is high, a lake, and the ocean, for example, relates to underwater organic substance strippers, such as a water purifier, and an underwater organic substance removal system.

[0002]

[Description of the Prior Art] As typical matter of the organic substance in a waterworks, trihalomethane (henceforth, THM), 2-methyl isoborneol (henceforth, MIB), and diosmin (henceforth, GEO) are mentioned. The approach of making the organic substance stick to the activated carbon, using activated carbon as an approach of removing these underwater organic substance, and removing, and the approach of filtering by the poly membrane and removing have been used conventionally. The former has mainly been used especially.

[0003] The disposable + exchange system of the adsorption treatment method by activated carbon discarding the activated carbon cartridge currently used before reaching adsorption saturation, and exchanging for a new activated carbon cartridge is almost the case. Moreover, in order to attain reinforcement of activated carbon, playback by hot water is also tried.

[0004]

[Problem(s) to be Solved by the Invention] There were the following technical problems in the conventional activated-charcoal-absorption removal method and the conventional carbon regeneration approach of disposable + exchange system.

[0005] Conventionally, activated carbon with hydrophobicity has been used as an adsorbent of the underwater organic substance. Activated carbon shows the property which was excellent compared with other ingredients to adsorption of THM, MIB, GEO, etc. by the liquid phase. However, about the life over THM, it is very as short as extent at the water purifier of the usual direct attachment type half a year, and semipermanent removal cannot be desired about other organic substance. For this reason, development of a long lasting adsorbent or the removal system made to prolongation-of-life-ize is pressing need to underwater organic substance removal.

[0006] Moreover, high exchange of frequency is not desirable from a viewpoint of that a disposable method has troublesome exchange of an activated carbon cartridge, or saving resources. Furthermore, when the activated carbon cartridge which adsorbed the used chlorine compound (THM) is discarded, there are many sources of anxiety — harmful gas occurs. Thus, the exchange type which results in extensive abandonment of used activated carbon has an expensive environmental load.

[0007] As an approach of attaining prolongation-of-life-ization of the above-mentioned activated-charcoal-absorption agent, hot water or the carbon regeneration by boiling is tried. Although it is possible to make it **** to low-boiling point compounds, such as THM, as for such hot water playback, the desorption of high-boiling point compounds, such as MIB and GEO, is difficult. Therefore, it does not result in full regeneration. Moreover, the high-boiling point compound accumulated on activated carbon through hot water playback may generate the organic halogenated compound which reacts with free chlorine and has a body bad influence. Thus, there are many technical problems at the hot water playback which does not result in full regeneration.

[0008] This invention aims at offering the underwater organic substance stripper excellent in adsorbent regenerative capacity, and an underwater organic substance removal system, without using on parenchyma and throwing away in consideration of the technical problem of the underwater organic substance removal by the activated-charcoal-absorption removal-playback approach of such conventional disposable + exchange system.

[0009]

[Means for Solving the Problem] The activated carbon with which the 1st this invention (it corresponds to claim 1) adsorbs the underwater organic substance, The photocatalyst matter which disassembles the underwater organic substance which touched said some of activated carbon [at least], and stuck to said activated carbon using a predetermined light, While containing the light source which can emit said light to said photocatalyst matter, and said activated carbon, said photocatalyst matter and said light source It is the underwater organic substance stripper characterized by having the stowage which has suicide-by-drowning opening which flows processed water, and the exhaust port which discharges the liquid which passed said activated carbon.

[0010] Processed water is flowed into a stowage, before it carries out adsorption treatment of the processed

underwater organic substance with activated carbon and it carries out an adsorption breakthrough, by carrying out an optical exposure, a photocatalyst is activated, an adsorption component is decomposed and activated carbon is reproduced. Therefore, removal capacity can continue over a long period of time from repeating adsorption-photoregeneration.

[0011] the 2nd this invention (it corresponds to claim 2) — each component of the underwater organic substance stripper of the 1st this invention — in addition, it is the underwater organic substance stripper characterized by having further a reflective means to reflect in said said activated carbon and photocatalyst matter side the light which it was prepared in the wall of said stowage and said light source emitted.

[0012] The 3rd this invention (it corresponds to claim 3) is an underwater organic substance stripper to which said activated carbon is characterized by supporting said photocatalyst matter on the front face in the underwater organic substance stripper of the 1st or 2nd this invention.

[0013] The 4th this invention (it corresponds to claim 4) is an underwater organic substance stripper to which said light source is characterized by the ability to emit said light intermittently in the underwater organic substance stripper of the 1st to 3rd one of this inventions.

[0014] The 5th this invention (it corresponds to claim 5) The underwater organic substance stripper plurality of the 1st to 4th one of this inventions, The suicide-by-drowning selection means for making said processed water flow into all or the part of said two or more underwater organic substance strippers, A treated water discharge means to discharge the treated water processed by said activated carbon from all or the part of said two or more underwater organic substance strippers, It is the underwater organic substance removal system characterized by having an organic substance content water discharge means to discharge a liquid including the decomposition product of the underwater organic substance which was sticking to said activated carbon disassembled with said photocatalyst matter from the part of said two or more underwater organic substance strippers.

[0015] Thus, by preparing two or more underwater organic substance strippers of the 1st to 4th one of this inventions, processed water can be processed by some [at least] underwater organic substance strippers, and the activated carbon of some underwater organic substance strippers can be used and reproduced for light to processing of the processed water and coincidence. Therefore, processing of processed water can be performed continuously.

[0016] In addition, after disassembling the organic substance which was sticking to activated carbon using light, it is necessary to let the processed water of a constant rate flow to activated carbon, to remove the decomposition product of the organic substance with the processed water, and to wash activated carbon. By doing in this way, a decomposition product can be discharged, and activated carbon can be *(ed) and reused.

[0017]

[Embodiment of the Invention] Below, the gestalt of operation of this invention is explained with reference to a drawing.

[0018] (Gestalt 1 of operation) The configuration of the underwater organic substance stripper of the gestalt 1 of operation of this invention is shown in drawing 1 . As shown in drawing 1 , the underwater organic substance stripper of the gestalt 1 of operation While containing the photocatalyst support activated carbon layer 5 which adsorbs the underwater organic substance and is supporting the photocatalyst matter on the front face, the light source 4 which can emit light to the photocatalyst matter, and the photocatalyst support activated carbon layer 5 and the light source 4 It is prepared in the wall of the stowage 16 which has the suicide-by-drowning opening 14 which flows processed water into the photocatalyst support activated carbon layer 5, and the exhaust port 15 which discharges the liquid which passed the photocatalyst support activated carbon layer 5, and a stowage 16, and consists of reflective film 3 which reflects in the photocatalyst support activated carbon layer 5 side the light which the light source 4 emitted. In addition, the photocatalyst matter currently supported by the photocatalyst support activated carbon layer 5 disassembles the underwater organic substance which stuck to activated carbon using the light from the light source 4. Moreover, the light source 4 is installed in the interior or the periphery section of the photocatalyst support activated carbon layer 5.

[0019] The activated carbon of the photocatalyst support activated carbon layer 5 has desirable shape of a grain and fibrous thing in consideration of pressure loss. The photocatalyst matter has an engine-performance side and a safety aspect to the most desirable titanium oxide. As for the support approach of the photocatalyst matter to activated carbon, a sol gel process, a CVD method, a spraying process, etc. are mentioned. The materials design which took depositing any approach in homogeneity in the state of not making pore of activated carbon blockade or a particle into consideration is required.

[0020] It mentions above, and as shown in drawing 1 , the light source 4 is arranged in the interior or the periphery section of the activated carbon layer 5. This is a catalytic activity-ized means at the time of making a photocatalyst decompose the activated-charcoal-adsorption component which resulted in adsorption saturation, and is indispensable. As the light source 4, when using titanium oxide as photocatalyst matter, the light source which emits the light of the wavelength region corresponding to the band gap of titanium oxide is desirable. The black light etc. corresponds to this.

[0021] The reflective film 3 aims at covering beams of light, such as ultraviolet rays from the stowage 16 outside, and efficient use of the beam of light which activates the photocatalyst matter. Since the resin is degraded as well as ultraviolet rays etc. being harmful to the body when forming a stowage 16 by resin, when forming a stowage 16 using a resin ingredient, electric shielding of the light from the stowage 16 outside is indispensable. Therefore, as an ingredient suitable for the reflective film 3, resin or a ceramic ingredient etc. which performed a metal and metal

plating is mentioned.

[0022] Now, in case the underwater organic substance stripper of the gestalt 1 of operation is used, the 1st valve 1 and 2nd valve 2 are opened wide, and the inside of the activated carbon layer 5 is passed for processed water. The underwater organic substance sticks to activated carbon in the case of the passage. The underwater organic substance which the predetermined time amount light source 4 was made to generate light irregularly periodically as it was called 1 time at one week, was made to activate the photocatalyst matter, and stuck to activated carbon there is made to disassemble. Then, the decomposition product of the underwater organic substance is taken and removed from activated carbon by passing the inside of the activated carbon layer 5 for processed water. When it does in this way, it is reproduced and activated carbon stops needing exchange. Here, it should take on the basis of the time amount taken for THM which is a low-boiling point compound to reach adsorption saturation, time amount, i.e., adsorption time amount, until it results in the following optical exposure through an optical exposure. moreover, the total by which the number of chloride ion contained in the decomposition liquid after a Mitsuteru putting exposure stuck to activated carbon after optical irradiation time carried out the adsorption breakthrough of the THM — it is desirable to make time amount until it results in 80% of the chlorine atomic number of THM into the criteria of optical irradiation time.

[0023] In addition, although the photocatalyst matter is supported by the photocatalyst support activated carbon layer 5 with the gestalt 1 of operation mentioned above, it is good, though magnitude of each photocatalyst matter is made into magnitude comparable as the magnitude of each activated carbon and the photocatalyst matter and activated carbon are mixed physically. In short, the photocatalyst matter must touch some activated carbon [at least], and has only to disassemble the underwater organic substance which stuck to activated carbon using light. Also when mixing the photocatalyst matter and activated carbon physically, granular or the thing of activated carbon which fixed titanium oxide and titanium oxide is [fibrous and a photocatalyst] desirable.

[0024] Moreover, with the gestalt 1 of operation mentioned above, although the photocatalyst matter has desirable titanium oxide, the photocatalyst matter is not limited to titanium oxide. In short, the photocatalyst matter has only to disassemble the underwater organic substance which stuck to activated carbon using light.

[0025] Furthermore, the light source 4 is good also as what can emit light intermittently. If it does in this way, energy at the time of emitting light can be made small. Make it however, better for the light source 4 to generate light continuously for the purpose of activating the photocatalyst matter.

[0026] (Gestalt 2 of operation) The underwater organic substance removal structure of a system of the gestalt 2 of operation of this invention is shown in drawing 2. As shown in drawing 2, in the underwater organic substance removal system of the gestalt 2 of operation, 6 and 7 are arranged to juxtaposition two underwater organic substance strippers (A and B) explained with the gestalt 1 of operation, the 1st change valve 8 is formed in the suicide-by-drowning opening upper part of each underwater organic substance stripper, the 2nd change valve 9 is formed in the exhaust-port lower part, it lets water flow in an activated carbon layer at the time, and it usually carries out adsorption treatment of the dissolved organic substance. And close the 1st change valve 8 and the 2nd change valve 9 intermittently, and the activated carbon layer 5 is made to activate the photocatalyst contained in the activated carbon layer 5 by carrying out an optical exposure from the light source 4, and decomposition and photoregeneration of activated carbon are performed for an adsorption component.

[0027] In addition, the BAJJI type photoregeneration which closes the 1st change valve 8 and the 2nd change valve 9 is indispensable in order to prevent leakage of the beam of light to which degradation of resin etc. is urged, and the leakage to the treated water of the liquid containing a high-concentration decomposition product. When treated water is a bevel use, it is still more so.

[0028] Two underwater organic substance strippers [two] (A and B) Or the inside of 6 and 7, When the underwater organic substance stripper A6 is during photoregeneration, processed water is flowed into the underwater organic substance stripper B7 by the 1st change valve 8. Adsorption treatment is performed, when underwater organic substance stripper B7B results and carries out photoregeneration to adsorption saturation conversely, passage is changed by the 1st change valve 8, and treated water is considered as an inflow and the continuous system removal which repeats a series of actuation which carries out adsorption treatment at the underwater organic substance stripper A6 which playback ended. Although adsorption treatment is impossible in the case of photoregeneration when only one underwater organic substance stripper is used, it is parallel and continuous duty is possible by using the two structures.

[0029] In case the organic substance which stuck to activated carbon is disassembled and the decomposition product of the organic substance is removed, it lets the processed water of a constant rate flow in the activated carbon layer 5, and washing of discharge and the activated carbon layer 5 is performed for the photo-regenerating liquid produced by organic substance decomposition produced by playback, and a passage setup of the feed hopper of treated water and the exhaust port of photo-regenerating liquid by adsorption treatment is carried out by the 3rd change valve 9. The partial oxidation object which did not result in the decomposed chlorine ion or full decomposition exists in the activated carbon after disassembly of the organic substance by the photocatalyst matter in large quantities, and there is possibility of re-adsorption in it. Therefore, it is necessary to discharge liquid including these decomposition products, to let water flow further, and to wash the inside of a system. As for the amount of water flow here, it is desirable to be based on the amount of water by which a full permutation is carried out by the inside of the system of an underwater organic substance stripper.

[0030] In addition, although [the gestalt 2 of operation mentioned above] an underwater organic substance removal system arranges the underwater organic substance stripper explained with the gestalt 1 of operation to

two-piece juxtaposition, the underwater organic substance stripper arranged at juxtaposition is not limited to two pieces. In short, two or more underwater organic substance strippers have only to arrange juxtaposition.

[0031]

[Example] First, the THM adsorption capacity of the physical mixture of activated carbon, photocatalyst support activated carbon, and a photocatalyst and activated carbon was investigated. The trial was performed in the following ways. The granular thing with a 8 - 15mesh and specific-surface-area 1050m²/g and an average pore diameter of 8A was used for activated carbon. This was made into Adsorbent A. What supported titanium oxide with rate of support 10wt% with the sol gel process to said granular active carbon was used for photocatalyst support activated carbon. Titanium oxide had the crystal structure of an anatase. This was made into Adsorbent B. The physical mixture of a photocatalyst and activated carbon used what fixed the particle titanium oxide of a 50-100nm anatase to the silica bead of 8 - 15mesh, and the thing which mixed said granular active carbon by 2:1. This was made into Adsorbent C.

[0032] The diameter of 5cm and the column made from a quartz of a cylindrical shape were filled up with adsorbent A100g, adsorbent B110g, and adsorbent C150g, respectively. The processed water containing THM50ppb, MIB100ppt, and GEO100ppt was flowed into this by 25 degrees C and 500 ml/min, and the matter concentration of a column outlet side was observed to it, and it was asked for aging of an elimination factor. A result is shown in (Table 1).

[0033]

[Table 1]

THM除去率 (%)			
通水量 (l)	吸着剤A	吸着剤B	吸着剤C
100	95	92	95
500	72	60	73
1000	46	39	44
2000	0	0	3
MIB除去率 (%)			
通水量 (l)	吸着剤A	吸着剤B	吸着剤C
100	85	82	88
500	80	80	87
1000	73	70	71
2000	58	50	60
GEO除去率 (%)			
通水量 (l)	吸着剤A	吸着剤B	吸着剤C
100	98	99	98
500	95	95	92
1000	88	82	91
2000	77	72	70

The adsorption breakthrough of the THM was carried out among the amounts 1500-2000l. of water flow as shown in (Table 1).

[0034] Next, activated carbon was regenerated. About Adsorbent A, it let 70-degree C hot water flow in the sample after the above-mentioned adsorption breakthrough trial by 500 ml/min for 30 minutes, and hot water playback was performed in it. About Adsorbents B and C, the optical exposure was performed for 10 hours, after installing equally six cylindrical shape germicidal lamp glass with 10W, a diameter [of 2cm], and a die length of 30cm in the periphery section of the column after an adsorption breakthrough trial similarly and closing suicide-by-drowning opening of a column, and an exhaust port. It let 10l. of 25-degree C pure water flow after the optical

exposure, and the inside of a column was washed.

[0035] The adsorption breakthrough trial of THM+MIB+GEO was again performed about the sample of A, B, and C to which it regenerated. The result of the adsorption breakthrough trial after regeneration is shown in (Table 2).

[0036]

[Table 2]

THM除去率 (%)			
通水量 (l)	吸着剤A	吸着剤B	吸着剤C
100	7.8	8.5	8.1
500	3.1	5.0	4.7
1000	7	2.2	1.8
2000	0	0	0
MIB除去率 (%)			
通水量 (l)	吸着剤A	吸着剤B	吸着剤C
100	6.0	7.9	8.2
500	1.1	8.0	8.2
1000	0	6.5	6.0
2000	0	4.8	4.4
GEO除去率 (%)			
通水量 (l)	吸着剤A	吸着剤B	吸着剤C
100	7.2	9.1	9.6
500	8	8.4	9.0
1000	0	7.2	6.5
2000	0	5.9	6.7

Although THM tends to be reproduced in A by hot water playback as shown in (Table 2), about other matter, the adsorption engine performance is falling clearly. On the other hand, although degradation of B and C which performed photocatalyst playback is carried out slightly, the ability to regenerate is superior to A.

[0037] Next, the following experiments were conducted in order to investigate the effectiveness of the reflective film.

[0038] It was made for a package and light not to reveal the quartz column which installed germicidal lamp glass in the periphery section similarly, and installed germicidal lamp glass in the periphery section with aluminum foil about the adsorbent B which carried out the adsorption breakthrough by said adsorption breakthrough trial. Thus, aluminum foil was used for the reflective film and Mitsuteru putting playback was performed for 10 hours. About the sample after playback, it let 10l. of 25-degree C pure water flow, and the inside of a column was washed.

[0039] The adsorption breakthrough trial of THM+MIB+GEO was again performed about the sample in which it regenerated using the reflective film. The result of the adsorption breakthrough trial after the regeneration which used the reflective film was shown in (Table 3), and it compared with the case where the reflective film is not used.

[0040]

[Table 3]

THM除去率 (%)		
通水量 (l)	反射膜あり	反射膜なし
100	92	85
1000	39	22
2000	0	0
MIB除去率 (%)		
通水量 (l)	反射膜あり	反射膜なし
100	84	79
1000	73	65
2000	56	48
GEO除去率 (%)		
通水量 (l)	反射膜あり	反射膜なし
100	91	91
1000	90	72
2000	67	59

The playback effectiveness of the adsorbent by the reflective film was shown as shown in (Table 3).

[0041]

[Effect of the Invention] This invention can offer the underwater organic substance stripper which exchange of activated carbon is parenchyma top needlessness, and demonstrates the removal engine performance of the underwater organic substance over a long period of time, and an underwater organic substance removal system, without throwing away using activated carbon on parenchyma so that clearly from the place explained above.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The block diagram of the underwater organic substance stripper of the gestalt 1 of operation of this invention

[Drawing 2] The underwater organic substance removal structure-of-a-system Fig. of the gestalt 2 of operation of this invention

[Description of Notations]

1 1st Valve

2 2nd Valve

3 Reflective Film

4 Light Source

5 Photocatalyst Support Activated Carbon Layer

14 Suicide-by-Drowning Opening

15 Exhaust Port

16 Stowage

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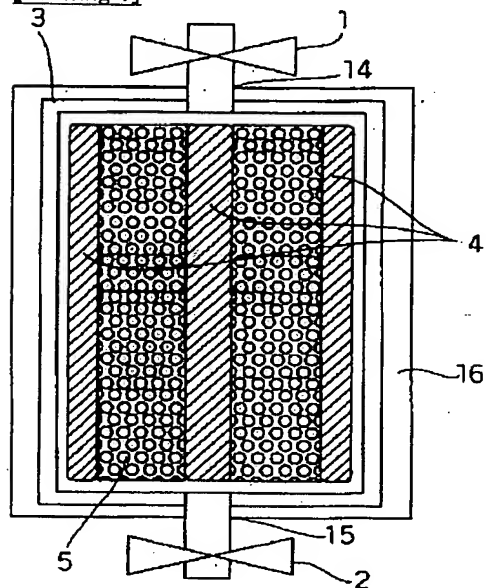
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DRAWINGS

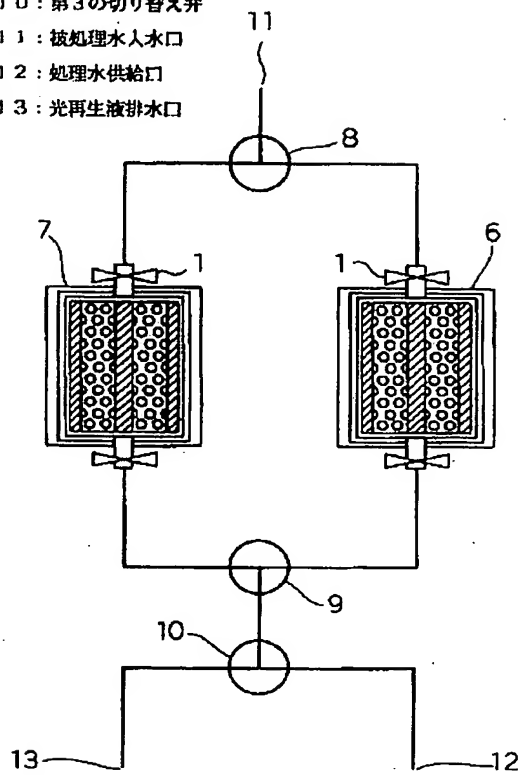
[Drawing 1]



- 1 : 第1の弁
- 2 : 第2の弁
- 3 : 反射膜
- 4 : 光源
- 6 : 光触媒担持活性炭層

[Drawing 2]

- 6 : 水中有機物除去装置 A
- 7 : 水中有機物除去装置 B
- 8 : 第 1 の切り替え弁
- 9 : 第 2 の切り替え弁
- 10 : 第 3 の切り替え弁
- 11 : 被処理水入水口
- 12 : 処理水供給口
- 13 : 光再生液排水口



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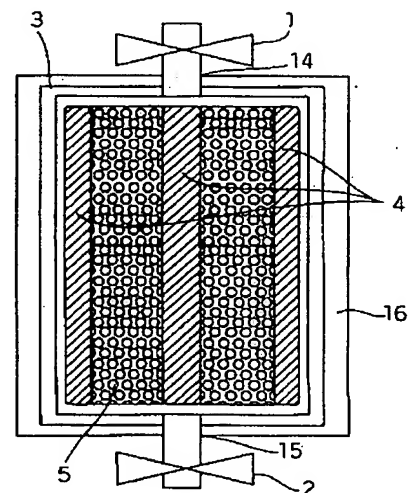
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(54) 【発明の名称】 水中有機物除去装置および水中有機物除去システム

(57) 【要約】

【課題】 従来、水中有機物を除去するための活性炭を使い捨てにしていた。

【解決手段】 表面に光触媒物質を担持し、水中有機物を吸着する光触媒担持活性炭層5と、光触媒物質に光を発することができる光源4と、活性炭層5および光源4を収納するとともに、被処理水を流入する入水口14、および活性炭層5を通過した液体を排出する排水口15を有する収納部16と、収納部16の内壁に設けられ、光源4が発した光を活性炭層5側に反射する反射膜3とを備え、光触媒物質として、光を利用して、活性炭層5に吸着した水中有機物を分解するものを用いる。そして、水中有機物の分解物を被処理水等を利用して取り除く。



- 1 : 第1の弁
- 2 : 第2の弁
- 3 : 反射膜
- 4 : 光源
- 5 : 光触媒担持活性炭層

【特許請求の範囲】

【請求項 1】 水中有機物を吸着する活性炭と、前記活性炭の少なくとも一部に接し、所定の光を利用して、前記活性炭に吸着した水中有機物を分解する光触媒物質と、

前記光触媒物質に前記光を発することができる光源と、前記活性炭、前記光触媒物質および前記光源を収納するとともに、被処理水を流入する入水口、および前記活性炭を通過した液体を排出する排水口を有する収納部とを備えたことを特徴とする水中有機物除去装置。

【請求項 2】 前記収納部の内壁に設けられ、前記光源が発した光を前記活性炭側および前記光触媒物質側に反射する反射手段をさらに備えたことを特徴とする請求項 1 記載の水中有機物除去装置。

【請求項 3】 前記活性炭は、表面に前記光触媒物質を担持していることを特徴とする請求項 1 または 2 記載の水中有機物除去装置。

【請求項 4】 前記光源は、間欠的に前記光を発することができることを特徴とする請求項 1 から 3 のいずれかに記載の水中有機物除去装置。

【請求項 5】 請求項 1 から 4 のいずれかに記載の水中有機物除去装置複数個と、

前記複数の水中有機物除去装置のうちの全部または一部に前記被処理水を流入させるための入水選択手段と、前記複数の水中有機物除去装置のうちの全部または一部からの、前記活性炭によって処理された処理水を排出する処理水排出手段と、

前記複数の水中有機物除去装置のうちの一部からの、前記光触媒物質によって分解された、前記活性炭に吸着していた水中有機物の分解物を含む液体を排出する有機物含有水排出手段とを備えたことを特徴とする水中有機物除去システム。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、上下水道をはじめ生活雑排水、尿尿処理水、工業排水、汚染度の高い河川、湖沼、海洋中の有機物を除去する、例えば浄水器等の水中有機物除去装置および水中有機物除去システムに関するものである。

【0002】

【従来の技術】上水中の有機物の代表的な物質としては、トリハロメタン（以下 THM）、2-メチルイソボルネオール（以下 MIB）、ジオスミン（以下 GEO）が挙げられる。これらの水中有機物を除去する方法として、従来、活性炭を用いてその活性炭に有機物を吸着させて除去する方法や、高分子膜によりろ過して除去する方法が用いられてきた。中でも前者が主に用いられてきた。

【0003】活性炭による吸着除去法は、吸着飽和に達する前に使用している活性炭カートリッジを廃棄し、新

しい活性炭カートリッジと交換するという使い捨て+交換方式がほとんどである。また、活性炭の長寿命化を図るため、熱水による再生も試みられている。

【0004】

【発明が解決しようとする課題】従来の使い捨て+交換方式の活性炭吸着除去法と活性炭再生方法には以下の課題があった。

【0005】従来、水中有機物の吸着剤として、疎水性を有した活性炭が用いられてきた。活性炭は液相での THM、MIB、GEO などの吸着には他の材料に比べ優れた特性を示す。しかしながら、THM に対する寿命に関しては通常の直結型の浄水器で半年程度と極めて短く、他の有機物に関しても半永久的な除去は望めない。このため、水中有機物除去に対し長寿命である吸着剤、もしくは延命化させる除去システムの開発が急務である。

【0006】また、使い捨て方式は、活性炭カートリッジの交換が面倒であることや省資源の観点からも頻度の高い交換は望ましくない。さらに、使用済みの塩素化合物（THM）を吸着した活性炭カートリッジを廃棄すると、有害ガスが発生するなど懸念材料が多い。このように、使用済み活性炭の大量廃棄に至る交換式は環境負荷が高い。

【0007】前述の活性炭吸着剤の延命化を図る方法として、熱水もしくは煮沸による活性炭再生が試みられている。このような熱水再生は、THM などの低沸点化合物に対しては脱離させることが可能であるが、MIB や GEO などの高沸点化合物の脱離は困難である。従って、完全再生には至らない。また、熱水再生を経て活性炭上に蓄積された高沸点化合物は、遊離塩素と反応して人体悪影響を与える有機ハロゲン化合物を生成する可能性がある。このように、完全再生に至らない熱水再生では課題が多い。

【0008】本発明は、このような従来の使い捨て+交換方式の活性炭吸着除去+再生方法による水中有機物除去の課題を考慮し、実質上使い捨てることなく、吸着剤再生能に優れた水中有機物除去装置および水中有機物除去システムを提供することを目的とする。

【0009】

【課題を解決するための手段】第 1 の本発明（請求項 1 に対応）は、水中有機物を吸着する活性炭と、前記活性炭の少なくとも一部に接し、所定の光を利用して、前記活性炭に吸着した水中有機物を分解する光触媒物質と、前記光触媒物質に前記光を発することができる光源と、前記活性炭、前記光触媒物質および前記光源を収納するとともに、被処理水を流入する入水口、および前記活性炭を通過した液体を排出する排水口を有する収納部とを備えたことを特徴とする水中有機物除去装置である。

【0010】収納部に被処理水を流入し、被処理水中の有機物を活性炭により吸着除去し、吸着破過する前に光

照射することにより光触媒を活性化し、吸着成分を分解、活性炭を再生する。従って、吸着—光再生を繰り返すことより除去能力が長期間にわたり持続可能である。

【0011】第2の本発明（請求項2に対応）は、第1の本発明の水中有機物除去装置の各構成要素に加えて、前記収納部の内壁に設けられ、前記光源が発した光を前記活性炭側および前記光触媒物質側に反射する反射手段をさらに備えたことを特徴とする水中有機物除去装置である。

【0012】第3の本発明（請求項3に対応）は、第1または第2の本発明の水中有機物除去装置において、前記活性炭が、表面に前記光触媒物質を担持していることを特徴とする水中有機物除去装置である。

【0013】第4の本発明（請求項4に対応）は、第1から第3のいずれかの本発明の水中有機物除去装置において、前記光源が、間欠的に前記光を発することができることを特徴とする水中有機物除去装置である。

【0014】第5の本発明（請求項5に対応）は、第1から第4のいずれかの本発明の水中有機物除去装置複数個と、前記複数の水中有機物除去装置のうちの全部または一部に前記被処理水を流入させるための入水選択手段と、前記複数の水中有機物除去装置のうちの全部または一部からの、前記活性炭によって処理された処理水を排出する処理水排出手段と、前記複数の水中有機物除去装置のうちの一部からの、前記光触媒物質によって分解された、前記活性炭に吸着していた水中有機物の分解物を含む液体を排出する有機物含有水排出手段とを備えたことを特徴とする水中有機物除去システムである。

【0015】このように、第1から第4のいずれかの本発明の水中有機物除去装置を複数個設けることにより、少なくとも一部の水中有機物除去装置で被処理水を処理することができ、その被処理水の処理と同時に、一部の水中有機物除去装置の活性炭を光を用いて再生することができる。したがって、被処理水の処理を連続して行うことができる。

【0016】なお、光を用いて活性炭に吸着していた有機物を分解した後、一定量の被処理水を活性炭に通水し、有機物の分解物をその被処理水で取り除き、活性炭の洗浄を行う必要がある。このようにすることにより、分解物を排出、活性炭を洗い再利用することができる。

【0017】

【発明の実施の形態】以下に、本発明の実施の形態を図面を参照して説明する。

【0018】（実施の形態1）図1に、本発明の実施の形態1の水中有機物除去装置の構成を示す。図1に示すように、実施の形態1の水中有機物除去装置は、水中有機物を吸着し、表面に光触媒物質を担持している光触媒担持活性炭層5と、光触媒物質に光を発することができる光源4と、光触媒担持活性炭層5および光源4を収納するとともに、光触媒担持活性炭層5に被処理水を流入

する入水口14、および光触媒担持活性炭層5を通過した液体を排出する排水口15を有する収納部16と、収納部16の内壁に設けられ、光源4が発した光を光触媒担持活性炭層5側に反射する反射膜3とから構成される。なお、光触媒担持活性炭層5に担持されている光触媒物質は、光源4からの光を利用して、活性炭に吸着した水中有機物を分解するものである。また、光源4は、光触媒担持活性炭層5の内部もしくは外周部に設置される。

【0019】光触媒担持活性炭層5の活性炭は圧力損失を考慮すると粒状もしくは繊維状のものが好ましい。光触媒物質は性能面、安全面から酸化チタンが最も好ましい。活性炭への光触媒物質の担持方法は、ゾルゲル法、CVD法、溶射法などが挙げられる。いずれの方法も、活性炭の細孔を閉塞させないことや微粒子の状態で均一に析出させることを考慮に入れた材料設計が必要である。

【0020】上述し、図1に示すように、活性炭層5の内部もしくは外周部には光源4を配置する。これは、吸着飽和に至った活性炭吸着成分を光触媒で分解させる際の触媒活性化手段であり不可欠である。光源4としては、光触媒物質として酸化チタンを用いる場合、酸化チタンのバンドギャップに対応する波長域の光を発する光源が好ましい。ブラックライトなどがこれに該当する。

【0021】反射膜3は、収納部16外部からの紫外線などの光線を遮蔽することと、光触媒物質を活性化させる光線の効率的な利用を目的としている。紫外線などは人体に有害なことは勿論、収納部16を樹脂で形成する場合、その樹脂を劣化させるので、樹脂材料を用いて収納部16を形成する場合、収納部16外部からの光の遮蔽は不可欠である。従って反射膜3に適する材料としては、金属および金属めっきを施した樹脂またはセラミック材料などが挙げられる。

【0022】さて、実施の形態1の水中有機物除去装置を使用するさい、第1の弁1および第2の弁2を開放し、被処理水を活性炭層5内を通過させる。その通過のさい、活性炭に水中有機物が吸着する。そこで、例えば1週間に1度といったように定期的に、または不定期的に、所定の時間光源4に光を発生させ、光触媒物質を活性化させて活性炭に吸着した水中有機物を分解させる。その後、被処理水を活性炭層5内を通過させることによって、水中有機物の分解物を活性炭からとり除く。このようにすると、活性炭は再生され、交換を必要としなくなる。ここで、光照射を経て次の光照射に至るまでの時間、すなわち、吸着時間は低沸点化合物であるTHMが吸着飽和に達するのに要する時間を基準にとるべきである。また、光照射時間はTHMを吸着破過させた後、光照射し照射後の分解液に含まれる塩化物イオン数が、活性炭に吸着した全THMの塩素原子数の80%に至るまでの時間を光照射時間の基準とするのが好ましい。

【0023】なお、上述した実施の形態1では、光触媒物質は、光触媒担持活性炭層5に担持されたとしたが、光触媒物質それぞれの大きさを、活性炭それぞれの大きさと同程度の大きさとし、光触媒物質と活性炭とを物理的に混合するとしてもよい。要するに、光触媒物質は、活性炭の少なくとも一部に接し、光を利用して、活性炭に吸着した水中有機物を分解するものでありさえすればよい。光触媒物質と活性炭とを物理的に混合する場合も活性炭は粒状もしくは繊維状、光触媒は酸化チタンおよび、酸化チタンを固定したものが望ましい。

【0024】また、上述した実施の形態1では、光触媒物質は酸化チタンが好ましいとしたが、光触媒物質は酸化チタンに限定されない。要するに、光触媒物質は、光を利用して、活性炭に吸着した水中有機物を分解するものでありさえすればよい。

【0025】さらに、光源4は、間欠的に光を発することができるとしてもよい。このようにすると、光を発するさいのエネルギーを小さくすることができる。ただし、光触媒物質を活性化させるという目的のためには、光源4には連続的に光を発生させる方がよい。

【0026】（実施の形態2）図2に、本発明の実施の形態2の水中有機物除去システムの構成を示す。図2に示すように、実施の形態2の水中有機物除去システムでは、実施の形態1で説明した水中有機物除去装置2個（AとB）6および7を並列に配置し、各水中有機物除去装置の入水口上部に第1の切り替え弁8を、排水口下部に第2の切り替え弁9を設け、通常時は活性炭層に通水し溶存有機物を吸着除去する。そして、間欠的に第1の切り替え弁8および第2の切り替え弁9を閉鎖し、かつ活性炭層5に光源4から光照射することにより活性炭層5に含有される光触媒を活性化させ、吸着成分を分解、活性炭の光再生を行う。

【0027】なお、第1の切り替え弁8および第2の切り替え弁9を閉鎖するパッチ式光再生は、樹脂の劣化などを促す光線の漏洩や、高濃度の分解物を含有した液の処理水への漏洩を防ぐために必要不可欠である。処理水が飲料用である場合は尚更である。

【0028】または、2つの水中有機物除去装置2個（AとB）6および7のうち、水中有機物除去装置A6が光再生中である場合は第1の切り替え弁8により水中有機物除去装置B7に被処理水を流入、吸着処理を行い、逆に水中有機物除去装置B7Bが吸着飽和に至り光再生する場合には、第1の切り替え弁8により流路を切り替え、再生の終了した水中有機物除去装置A6に処理水を流入、吸着除去させる一連の操作を繰り返す連続式除去とする。水中有機物除去装置を1つだけ用いた場合、光再生の際、吸着処理は不可能であるが、並列で2つの構造体を用いることにより連続使用が可能である。

【0029】活性炭に吸着した有機物を分解し、その有機物の分解物を取り除くさい、一定量の被処理水を活性

炭層5に通水し、再生によって生じた有機物分解によって生じた光再生液を排出、かつ活性炭層5の洗浄を行い、また、吸着処理による処理水の供給口と光再生液の排水口とを第3の切り替え弁9によって流路設定する。光触媒物質による有機物の分解後の活性炭には、分解された塩素イオンや完全分解に至らなかった部分酸化物などが大量に存在し、再吸着の可能性もある。したがって、これらの分解物を含んだ液を排出する必要がある。ここでの通水量は、水中有機物除去装置の系内が完全置換される水量を基準とするのが望ましい。

【0030】なお、上述した実施の形態2では、水中有機物除去システムは、実施の形態1で説明した水中有機物除去装置を2個並列に配置するとしたが、並列に配置される水中有機物除去装置は、2個に限定されることはない。要するに、複数個の水中有機物除去装置が並列に配置しさえすればよい。

【0031】

【実施例】まず始めに、活性炭、光触媒担持活性炭、光触媒と活性炭との物理混合物のTHM吸着容量を調べた。試験は以下の要領で行った。活性炭は、8~15 mesh、比表面積1050 m²/g、平均細孔径8オングストロームの粒状のものをを用いた。これを吸着剤Aとした。光触媒担持活性炭は、酸化チタンを前記粒状活性炭にゾルゲル法で担持率10wt%で担持したものをを用いた。酸化チタンはアナタース型の結晶構造を有していた。これを吸着剤Bとした。光触媒と活性炭の物理混合物は8~15 meshのシリカビーズに50~100 nmのアナタース型の微粒子酸化チタンを固定したものと前記粒状活性炭を2:1で混合したものをを用いた。これを吸着剤Cとした。

【0032】吸着剤A100g、吸着剤B110g、吸着剤C150gをそれぞれ直径5cm、円筒形の石英製カラムに充填した。これに、THM50ppb、MIB100ppt、GEO100pptを含有した被処理水を25℃、500ml/minで流入し、カラム出口側の物質濃度を観察し除去率の経時変化を求めた。結果を（表1）に示す。

【0033】

【表1】

THM除去率 (%)			
通水量 (l)	吸着剤A	吸着剤B	吸着剤C
100	95	92	95
500	72	60	73
1000	46	39	44
2000	0	0	3
MIB除去率 (%)			
通水量 (l)	吸着剤A	吸着剤B	吸着剤C
100	85	82	88
500	80	80	87
1000	73	70	71
2000	58	50	60
GEO除去率 (%)			
通水量 (l)	吸着剤A	吸着剤B	吸着剤C
100	98	99	98
500	95	95	92
1000	88	82	91
2000	77	72	70

(表1)に示す通り、THMは通水量1500~2000 lの間で吸着破過した。

【0034】次に活性炭の再生処理を行った。吸着剤Aについては、上記吸着破過試験後の試料に、70℃の熱水を500ml/minで30分通水し、熱水再生を行った。吸着剤B、Cについては、同じく吸着破過試験後のカラムの外周部に10W、直径2cm、長さ30cmの円筒形殺菌灯を均等に6本設置し、カラムの入水口、排水口を閉鎖した後、10時間光照射を行った。光照射後、25℃の純水を10 l通水し、カラム内を洗浄した。

【0035】再生処理を行ったA、B、Cの試料につき、再度THM+MIB+GEOの吸着破過試験を行った。(表2)に再生処理後の吸着破過試験の結果を示す。

【0036】

【表2】

THM除去率 (%)			
通水量 (l)	吸着剤A	吸着剤B	吸着剤C
100	78	85	81
500	31	50	47
1000	7	22	18
2000	0	0	0
MIB除去率 (%)			
通水量 (l)	吸着剤A	吸着剤B	吸着剤C
100	60	79	82
500	11	80	82
1000	0	65	60
2000	0	48	44
GEO除去率 (%)			
通水量 (l)	吸着剤A	吸着剤B	吸着剤C
100	72	91	96
500	8	84	90
1000	0	72	65
2000	0	59	67

(表2)に示す通り、熱水再生によるAでは、THMは再生される傾向があるが、その他の物質に関しては吸着性能は明らかに低下している。これに対し、光触媒再生を施したB、Cはわずかに性能低下しているが、再生能力はAより優れている。

【0037】次に、反射膜の効果を調べるため以下の実験を行った。

【0038】前記吸着破過試験により吸着破過させた吸着剤Bにつき、同様に殺菌灯を外周部に設置し、殺菌灯を外周部に設置した石英カラムをアルミ箔で包み、光が漏洩しないようにした。このように、アルミ箔を反射膜に用い、10時間光照射し再生を行った。再生後の試料につき、25℃の純水を10 l通水し、カラム内を洗浄した。

【0039】反射膜を用いて再生処理を行った試料につき、再度THM+MIB+GEOの吸着破過試験を行った。(表3)に反射膜を用いた再生処理後の吸着破過試験の結果を示し、反射膜を用いない場合と比較した。

【0040】

【表3】

THM除去率 (%)		
通水量 (l)	反射膜あり	反射膜なし
100	92	85
1000	39	22
2000	0	0
MIB除去率 (%)		
通水量 (l)	反射膜あり	反射膜なし
100	84	79
1000	73	65
2000	56	48
GEO除去率 (%)		
通水量 (l)	反射膜あり	反射膜なし
100	91	91
1000	90	72
2000	67	59

* (表3) に示す通り、反射膜による吸着剤の再生効果が示された。

【0041】

【発明の効果】以上説明したところから明らかなように、本発明は、活性炭を実質上使い捨てることなく、活性炭の交換が実質上不要で、かつ長期に渡り水中有機物の除去性能を発揮する水中有機物除去装置および水中有機物除去システムを提供することができる。

【図面の簡単な説明】

10 【図1】 本発明の実施の形態1の水中有機物除去装置の構成図

【図2】 本発明の実施の形態2の水中有機物除去システムの構成図

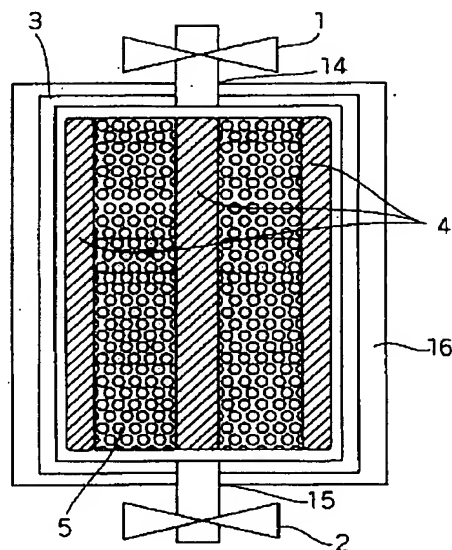
【符号の説明】

- 1 第1の弁
- 2 第2の弁
- 3 反射膜
- 4 光源
- 5 光触媒担持活性炭層

- 20 14 入水口
- 15 排水口
- 16 収納部

*

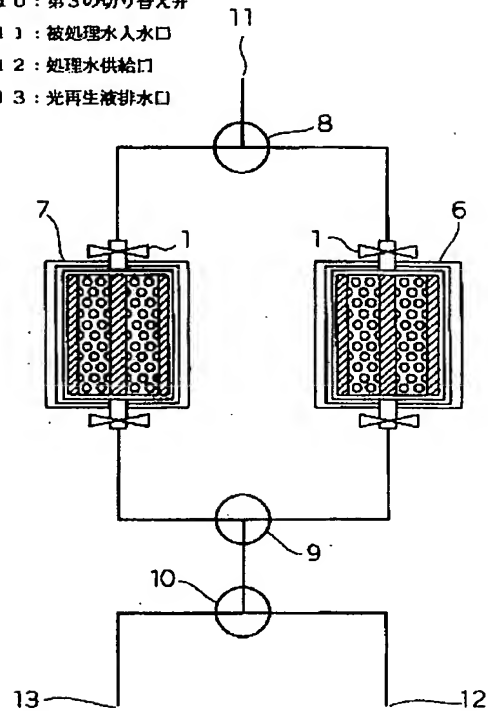
【図1】



- 1 : 第1の弁
- 2 : 第2の弁
- 3 : 反射膜
- 4 : 光源
- 5 : 光触媒担持活性炭層

【図2】

- 6 : 水中有機物除去装置 A
 7 : 水中有機物除去装置 B
 8 : 第1の切り替え弁
 9 : 第2の切り替え弁
 10 : 第3の切り替え弁
 11 : 被処理水入水口
 12 : 処理水供給口
 13 : 光再生液排水口



フロントページの続き

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